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***Title*:** Comparison of BEM and FDM head modeling in SPM for EEG source reconstruction based on free energy

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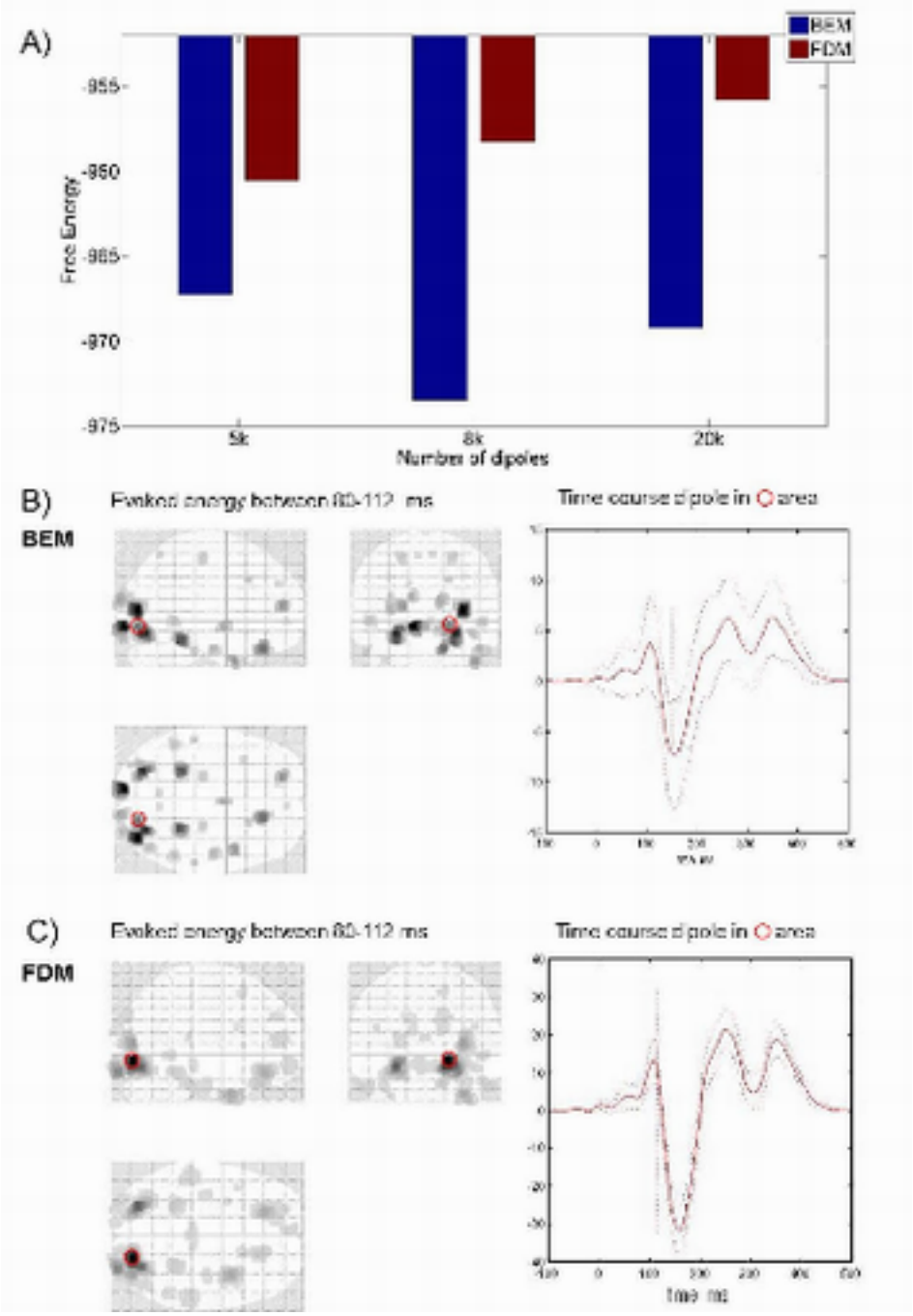
Abstract (2000 characters max.)

The boundary element method (BEM) is commonly used in EEG source reconstruction due to its efficient computational properties. Finite difference methods (FDM) are computationally more intensive but allow more realistic head modeling. Bayesian EEG source reconstruction techniques are implemented in the statistical parametric mapping software (SPM). They admit comparison of reconstructions based on their free energy values. Only BEM head models are however available in the SPM package. This work extends head modeling in SPM to FDM models.

We constructed an FDM model based on the default BEM surfaces and brain tissue conductivity values used in SPM. This to compare FDM and BEM modeling in similar conditions. For the comparison we reconstructed scalp EEG data from 26 subjects in a visual detection checkerboard task, for bottom left stimuli, based on the default number of dipoles (5124, 8196 and 20484) and dipole locations. The accuracy of the reconstructions was validated based on the results from previous EEG/fMRI checkerboard studies.

For the grand averaged data there was strong evidence that the FDM outperforms the BEM, i.e. we found Bayes factors > 150. The Free energy comparison for single subject reconstructions did not show strong evidence for either BEM or FDM modeling, i.e. we only found Bayes factors < 20. The results are shown in figure A. These results evidenced better performance of the

FDM with higher number of dipoles. The reconstruction results for the model of 20484 dipoles are presented in figures B and C for the BEM and the FDM respectively. The evoked energy between 80-112 ms corresponding with the early P1 peak is depicted on the left. The time course of the dipole with maximum energy for the FDM head model is shown on the right. The reconstruction results based on the FDM model correspond with the results from previous studies. The results are less clear for the BEM.



A) Free energy values of the grand averaged ERP reconstructions based on the BEM and FDM head models. B) and C) Left: evoked energy between 80 -112 ms for the reconstructions based on the BEM and FDM. Right: time course of the dipole in the red circled area.